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ZOISITE FROM LOWER CALIFORNIA

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While at San Diego, California, in the spring of 1905, the writer obtained from Mr. Ernest Riall of that city several specimens of a radiated mineral, collected by Mr. Riall at the Trace mine, in the Juarez District of Lower California. This locality, according to Mr. Riall, is situated sixty miles south of the international boundary. The accompanying cut shows the appearance of a typical specimen of the mineral. It occurs as divergent groups of long, prismatic crystals irregularly penetrating a matrix of a white, granular mineral. The length of the crystal groups varies from one to three inches. Their form is essentially conical, the angle of the cone being about 10° . In coloring the cones are pink peripherally, pass interiorly into nearly colorless and at the center are brownish-gray. Their constitution of numerous individual crystals is shown by elongated brilliant surfaces into which they readily separate longitudinally, but transversely the cones break as units. The cones as a whole are translucent, but small fragments are transparent. No terminal planes can be observed on any of the crystals. The longitudinal fragments show roughly prismatic boundaries, but it was found impossible, with a reflecting goniometer, to obtain satisfactory measurements of the prismatic angles, since numerous longitudinal striations produce long series of reflections. Besides the striated planes, others not striated appear to be cleavage planes to the brachypinacoid. The longitudinal fragments are colorless and transparent and show in polarized light extinction parallel to the long axis. No pleochroism is observable. The character of the double refraction is positive. In convergent light the emergence of an optic axis may be seen on such fragments. Sections perpendicular to the axis of the cone are colorless and show no pleochroism. Numerous cleavage cracks making angles of 53° with each other penetrate such sections. Between crossed nicols a polysynthetic twinning structure is seen to characterize the whole, the field being filled with lamellae in parallel position. These lamellae divide into two groups as regards width, the broader being from .1 to .07 mm. and the narrower from .025 to .012 mm. The broad and narrow lamellae alternate. The direction

of the lamellae is such as to bisect the above-noted cleavage angle of 53° . Single cleavage cracks \parallel with the lamellae are also occasionally seen.

The interpretation of this structure is difficult, but the following may be suggested: The cleavage cracks at angles of 53° are those of prisms of which the crystal groups are composed. These prisms have the symbol 540, corresponding to an angle of $52^\circ 44'$. This is a new form for zoisite. The twins of which these prisms are made up are formed on c as the twinning axis and the twinning plane is some highly inclined brachy-dome such as e (061).

The lustre of fragments of the mineral is vitreous and the fracture sub-conchoidal. Hardness 6.5 and specific gravity, determined with a chemical balance, 3.32. The mineral fuses B. B. at 3 with intumescence, to a brownish enamel and is only slightly attacked by hydrochloric acid. Qualitative tests showed it to be essentially a hydrous calcium aluminum silicate, from which the water could be driven off only by strong ignition. Quantitative analysis by Mr. H. W. Nichols gave the following result:

		<i>Ratio</i>
SiO ₂	38.15	3.02
Al ₂ O ₃	29.50	{ 1.51
Fe ₂ O ₃	4.60	
MnO	0.55	
CaO	22.71	{ 2.05
MgO	0.63	
H ₂ O	3.76	1.00
K ₂ O {	tr.	
Na ₂ O }		
	<hr/> 99.90	

These ratios lead to the formula $H_4 Ca_4 Al_6 Si_6 O_{27}$, which is that usually accepted for zoisite with the addition of one molecule of water. For the determination of the water both of Penfield's methods* were employed. By the first method, that of heating in a blast lamp, 1.81% of water was obtained. The mineral did not fuse. By the second method, which consists in heating the tube containing the assay in an oven of fire-brick lined with charcoal, an additional percentage of water amounting to 1.95% was obtained. Under this treatment the mineral fused completely. The close similarity between the percentages of water obtained by the two methods, each corresponding to one molecule, suggests that the molecules may be differently combined. Thus one may be united with aluminum and the other with

* Amer. Jour. Sci. 1894, 3rd ser. Vol. XLVIII, pp. 30-37

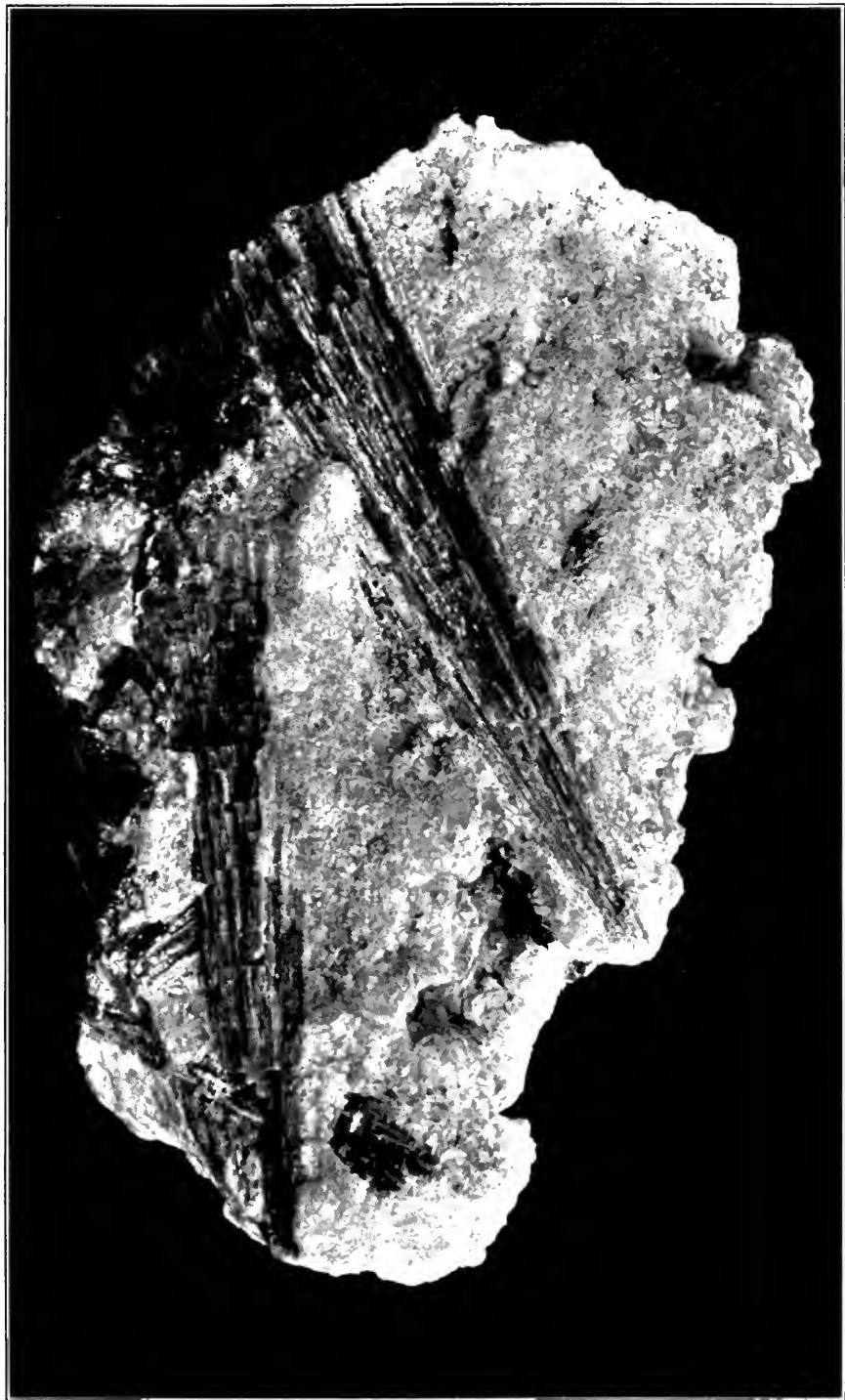
calcium. No further investigation was made of this point, however. Although the formula of zoisite is usually considered to be $H_2Ca_4Al_4Si_6O_{26}$, other analysts have obtained percentages which indicate that an additional molecule of water is present. This is true, for instance, of the analyses of zoisite from Fuschthal and Traversella quoted by Dana.* The high temperature required to drive off the water from the Lower California mineral seems to preclude the possibility of its being present as the result of alteration, as might otherwise be assumed. The amount of iron in the zoisite shown by the analysis is high for this mineral and approximates that afforded by epidote.

The mineral with which the zoisite is associated is, as stated, white and granular. In cavities it exhibits minute imperfect crystals which have a distinct, pearly luster when fractured. The blowpipe and other characters of this mineral indicate it to be prehnite and a comparison with fragments kindly furnished by Dr. W. T. Schaller leaves little doubt that it is the same mineral analyzed † by him and found to be prehnite. Its association with zoisite is of interest owing to the similarity in composition of the two minerals. The prehnite seems generally to furnish a matrix which the zoisite penetrates, but occasionally it coats the zoisite groups in such a way as to suggest that it is an alteration product of the latter. The unusual features of the zoisite seem to be therefore, its radiating habit, its high content of water and iron and its association with prehnite.

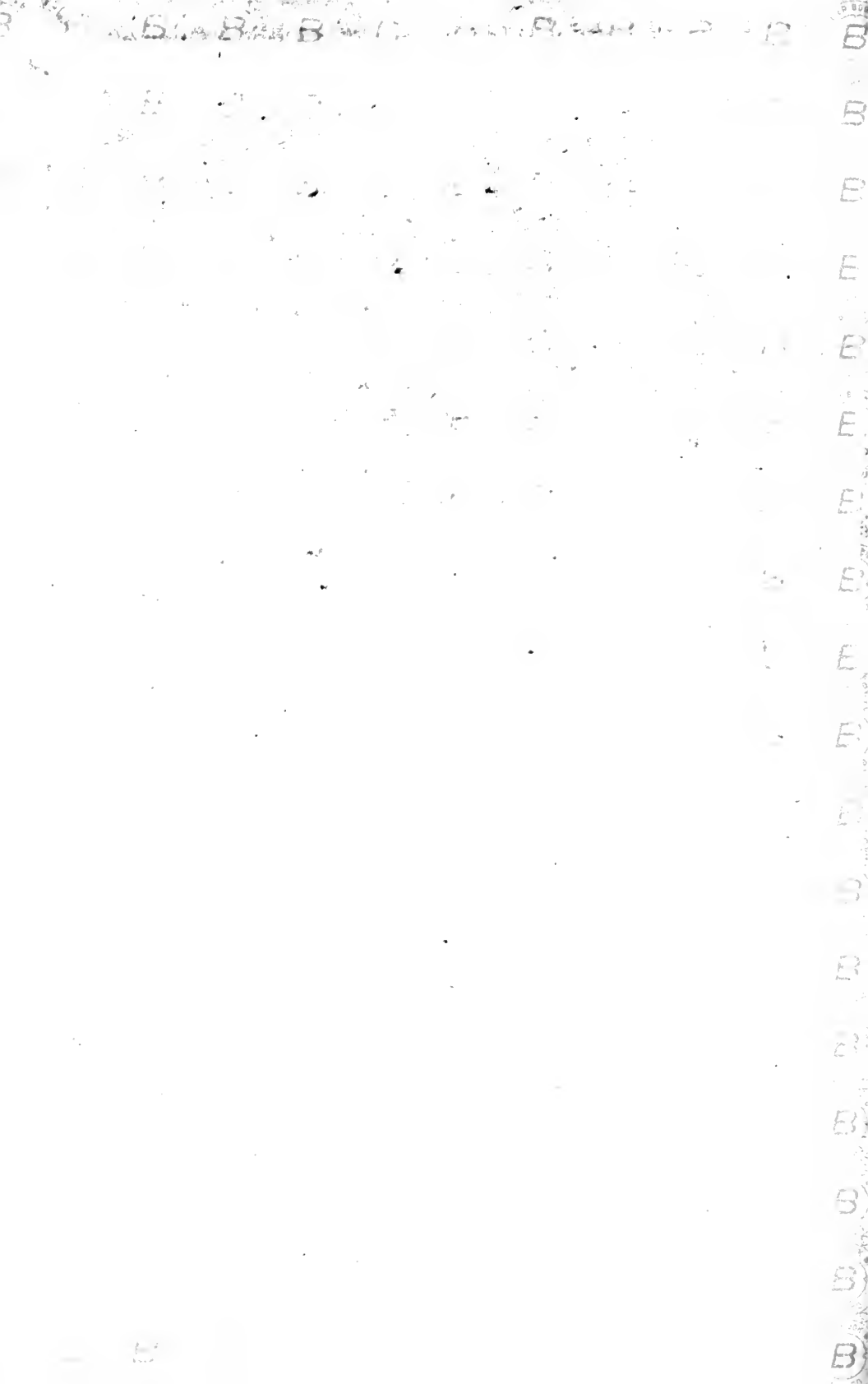
Through the kindness of Prof. L. P. Gratacap of the American Museum of Natural History, the writer was permitted to study two specimens of zoisite in the collection of that institution which were undoubtedly from the same locality as the above. They have the more usual ash-gray color of zoisite and the grouping of the crystals into cones is only partial. For the most part the crystals occur in hemispherical cavities which were, in the specimens studied, about three inches in diameter. The crystals interlace these cavities with great variations of size and direction. Many of the crystals are quite minute. All are from acicular to bladed in habit. Although some crystals have free terminations, no end faces could be discerned. These specimens show that grouping into cones is not constant for the zoisite from this locality but its occurrence at all is noteworthy.

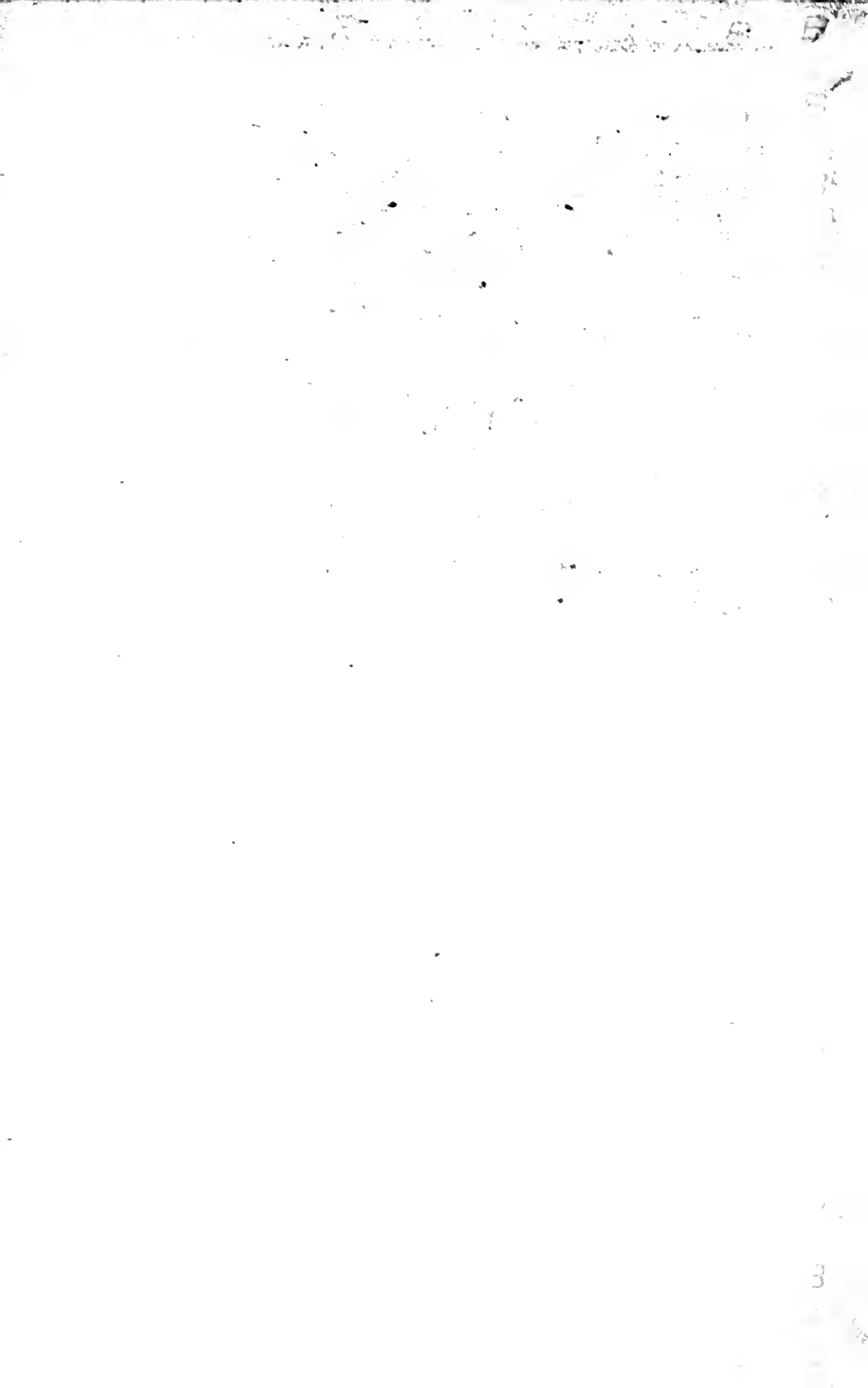
* System of Mineralogy, 6th ed., p. 514.

† Bull. U. S. Geol. Survey No. 262, p. 128



Zoisite in Prehnite, Lower California. $\times \frac{1}{2}$





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